

## NEW ZEALAND DATA SHEET

### MOXIFLOXACIN MEDSURGE (Moxifloxacin)

#### 1 PRODUCT NAME

Moxifloxacin Medsurge moxifloxacin 400 mg film coated tablet

#### 2 QUALITATIVE AND QUANTITATIVE COMPOSITION

Each tablet contains 436.34 mg moxifloxacin hydrochloride (as monohydrate), equivalent to 400 mg moxifloxacin.

For the full list of excipients, see Section 6.1 List of excipients.

#### 3 PHARMACEUTICAL FORM

Pink coloured, capsule shaped, biconvex, bevelled edge, film-coated tablet marked with 'MF' on one side and plain on other side.

#### 4 CLINICAL PARTICULARS

##### 4.1 Therapeutic indications

Moxifloxacin Medsurge tablets are indicated for the treatment of the following bacterial infections caused by susceptible strains:

- Bronchitis (acute exacerbations of chronic bronchitis)
- Pneumonia (community acquired)
- Sinusitis (acute)
- Complicated skin and skin structure infections (including diabetic foot infections)
- Complicated intra-abdominal infections including polymicrobial infections such as abscesses

Moxifloxacin Medsurge tablets are indicated for the treatment of the following bacterial infections caused by susceptible strains:

- Uncomplicated pelvic inflammatory disease (i.e. infections of female upper genital tract, including salpingitis and endometritis)

Consideration should be given to available official guidance on the appropriate use of antibacterial agents.

##### 4.2 Dose and method of administration

This medicine is available as a 400 mg film- coated tablet for oral administration.

*Moxifloxacin injection for intravenous infusion is unavailable in this brand however is available in other brands. Where correct dosing requires moxifloxacin injection formulation, refer to the specific product information for this formulation for their complete dosage and administration instructions.*

## Dose

The recommended dose for moxifloxacin is 400 mg once daily (1 film-coated tablet) for the above-mentioned indications and should not be exceeded.

### *Duration of Treatment*

The duration of treatment should be determined by the severity of the indication or clinical response. The following are general recommendations:

#### Film-coated tablet

Bronchitis: acute exacerbation of chronic bronchitis, 5 days

Pneumonia: community acquired pneumonia, 10 days

Sinusitis: acute sinusitis, 7 days

Complicated skin and skin structure infections total treatment duration for sequential therapy (intravenous followed by oral therapy): 7 – 21 days

Uncomplicated pelvic inflammatory disease: 14 days

Complicated intra-abdominal infections total treatment duration for sequential therapy (intravenous followed by oral therapy): 5 – 14 days

Moxifloxacin can be administered intravenously for the entire treatment duration. Alternatively, therapy may be initial intravenous administration, followed by oral administration of film-coated tablets when clinically indicated.

The recommended duration of treatment for the indication being treated should not be exceeded.

Moxifloxacin 400 mg film-coated tablets have been studied in clinical trials for up to 21 days (in complicated skin and skin structure infections).

### *Missed dose*

If a dose is missed, it should be taken as soon as the patient remembers on the same day. Double doses should not be taken to compensate for a missed dose.

### *Geriatric Patients*

No adjustment of dosage is required in the elderly.

### *Paediatric population*

Efficacy and safety of moxifloxacin in children and adolescents have not been established (see also Section 4.3 Contraindications).

### *Ethnic Differences*

No adjustment of dosage is required in ethnic groups.

### *Patients with Hepatic Impairment*

No dosage adjustment is required in patients with impaired liver function (see Section 4.4 Special warnings and precautions for use, for patients with liver cirrhosis).

### *Patients with Renal Impairment*

No dose adjustment is required for patients with renal impairment (including creatinine clearance  $\leq 30$  mL/min/1.73m<sup>2</sup>) and in patients on chronic dialysis i.e.

haemodialysis and continuous ambulatory peritoneal dialysis.

## **Method of Administration**

### *Film-coated tablet*

The film-coated tablet should be swallowed whole with sufficient liquid and may be taken independently of meals.

## **4.3 Contraindications**

Known hypersensitivity to moxifloxacin or other quinolones or any of the excipients.

Pregnancy and lactation.

Patients below 18 years of age.

## **4.4 Special warnings and precautions for use**

*Moxifloxacin injection for intravenous infusion is unavailable in this brand, however this dosage form is available in other brands. Special Warnings and Precautions For Use, Fertility, Pregnancy, Pharmacokinetic and Pharmacodynamic information obtained using the moxifloxacin injection for intravenous infusion formulation is also included in the following sections for prescriber information.*

Fluoroquinolones, including moxifloxacin, have been associated with disabling and potentially persistent adverse reactions involving different body systems that have occurred together in the same patient. These include, but are not limited to, serious adverse reactions involving the nervous system and musculoskeletal system.

### **Hypersensitivity**

In some instances, the hypersensitivity and allergic reactions occurred after the first administration and the doctor should be informed immediately.

Anaphylactic reactions in very rare instances can progress to a life threatening shock, in some instances after the first administration. In these cases the treatment with moxifloxacin must be discontinued, medical treatment (e.g. treatment for shock) is required.

Cases of bullous skin reactions like Stevens-Johnson syndrome or toxic epidermal necrolysis have been reported with moxifloxacin. Patients should be advised to contact their doctor immediately prior to continuing treatment if skin and/or mucosal reactions occur.

### **Cardiac disorders**

Moxifloxacin has been shown to prolong the QT interval of the electrocardiogram in some patients. As women tend to have a longer baseline QTc interval compared with men, they may be more sensitive to QTc-prolonging medications. Elderly patients may also be more susceptible to drug-associated effects on the QT interval. As the magnitude of QT prolongation may increase with increasing concentrations of the medicine, the recommended dose and the infusion rate (400 mg within 60 minutes) should not be exceeded. However, in patients suffering from pneumonia, no correlation between plasma concentrations of moxifloxacin and QTc prolongation was observed. QT prolongation may lead to an increased

risk for ventricular arrhythmias including torsades de pointes. No cardiovascular morbidity or mortality attributable to QTc prolongation occurred with moxifloxacin treatment in clinical studies with more than 9000 patients; however certain predisposing conditions may increase the risk for ventricular arrhythmias.

Therefore, treatment with moxifloxacin should be avoided due to the lack of clinical experience with the medicine in these patient populations:

- In patients with known prolongation of the QT interval
- In patients with uncorrected hypokalaemia
- In patients receiving class IA (e.g. quinidine, procainamide) or class III (e.g. amiodarone, sotalol) antiarrhythmic agents

Moxifloxacin should be used with caution as an additive effect of moxifloxacin on the QT interval cannot be excluded for the following conditions:

- In patients treated concomitantly with medicines that prolong the QT interval such as cisapride, erythromycin, antipsychotics and tricyclic antidepressants
- In patients with ongoing proarrhythmic conditions such as clinically significant bradycardia, acute myocardial ischaemia
- In patients with liver cirrhosis as pre-existing QT prolongation in these patients cannot be excluded
- In women and elderly patients who both may be more susceptible to QTc-prolonging medicines

### **Hepatobiliary system**

Cases of fulminant hepatitis potentially leading to liver failure (including fatal cases) have been reported with moxifloxacin (see Section 4.8 Undesirable effects). Patients should be advised to contact their doctor immediately prior to continuing treatment if symptoms related to liver failure occur.

### **Seizures**

Seizures may occur with fluoroquinolone therapy. moxifloxacin should be used with caution in patients with known or suspected CNS disorders (e.g. lowered convulsion threshold, previous history of convulsion, reduced cerebral blood flow, altered brain structure or stroke), which may predispose to seizures or lower the seizure threshold.

### **Gastrointestinal system**

Antibiotic associated colitis has been reported with the use of broad-spectrum antibiotics including moxifloxacin and may range in severity from mild diarrhoea to fatal colitis. Therefore it is important to consider this diagnosis in patients who develop serious diarrhoea in association with the use of moxifloxacin. If antibiotic associated colitis is suspected or confirmed, ongoing treatment with antibacterial agents, including moxifloxacin, should be discontinued and adequate therapeutic measures should be initiated immediately. Drugs inhibiting peristalsis are contraindicated in this situation.

### **Myasthenia gravis**

Moxifloxacin should be used with caution in patients with myasthenia gravis

because the symptoms can be exacerbated.

### **Tendinitis and tendon rupture**

Tendinitis and tendon rupture (predominantly Achilles tendon), sometimes bilateral, may occur with fluoroquinolone therapy including moxifloxacin, even within the first 48 hours of treatment. Cases occurring up to several months after completion of therapy have been reported. The risk of tendinopathy may be increased in elderly patients, during strenuous physical activity, in patients treated concomitantly with corticosteroids, in patients with renal impairment and patients with solid organ transplants. At the first sign of tendinitis (e.g. painful swelling, inflammation) the affected extremity should be kept at rest, any inappropriate physical exercise should be avoided, a physician should be consulted and the antibiotic treatment should be discontinued.

### **Skin and appendages**

Fluoroquinolones have been shown to cause photosensitivity reactions in patients. However, in specially designed preclinical and clinical studies photosensitivity has not been observed with moxifloxacin. In addition, since first marketed there has been no clinical evidence that moxifloxacin causes photosensitivity reactions. Nevertheless, patients should be advised to avoid extensive exposure to either UV irradiation or sunlight.

### **Complicated pelvic inflammatory disease**

For patients with complicated pelvic inflammatory disease (e.g. associated with a tubo-ovarian or pelvic abscess), for whom an intravenous treatment is considered necessary, treatment with moxifloxacin 400 mg tablets is not recommended.

### **MRSA infections**

Moxifloxacin is not recommended for the treatment of MRSA infections. In case of a suspected or confirmed infection due to MRSA, treatment with an appropriate antibacterial agent should be started (see Section 5.1 Pharmacodynamic properties).

### **Interaction with tests**

Moxifloxacin *in vitro* activity may interfere with the *Mycobacterium* spp. culture test by suppression of mycobacterial growth, causing false negative results in specimens from patients currently taking moxifloxacin.

### **Peripheral neuropathy**

Cases of sensory or sensorimotor polyneuropathy resulting in paraesthesias, hypoaesthesias, dysaesthesias or weakness have been reported in patients receiving fluoroquinolones including moxifloxacin. Patients under treatment with moxifloxacin should be advised to inform their doctor prior to continuing treatment if symptoms of neuropathy such as pain, burning, tingling, numbness or weakness develop (see Section 4.8 Undesirable effects).

### **Psychiatric reactions**

Psychiatric reactions may occur even after the first administration of

fluoroquinolones, including moxifloxacin. In very rare cases, depression or psychotic reactions have progressed to suicidal thoughts and self-injurious behavior such as suicide attempts (see Section 4.8 Undesirable effects). In the event that the patient develops these reactions, moxifloxacin should be discontinued and appropriate measures instituted. Caution is recommended if moxifloxacin is to be used in psychotic patients or in patients with a history of psychiatric disease.

### **Genital tract infections**

Because of the widespread and rising prevalence of fluoroquinolone-resistant *Neisseria gonorrhoeae* infections, monotherapy with moxifloxacin should be avoided in patients with pelvic inflammatory disease, unless fluoroquinolone-resistant *N. gonorrhoeae* can be excluded. If fluoroquinolone-resistant *N. gonorrhoeae* cannot be excluded, the addition of an appropriate antibiotic which is regularly active against *N. gonorrhoeae* (e.g. a cephalosporin) to empirical moxifloxacin therapy, should be considered.

### **Dysglycaemia**

As with all fluoroquinolones, disturbances in blood glucose, including both hypoglycaemia and hyperglycaemia, have been reported with moxifloxacin. In moxifloxacin-treated patients, dysglycaemia occurred predominantly in elderly diabetic patients receiving concomitant treatment with an oral hypoglycaemia agent (e.g. sulfonylurea) or with insulin. In diabetic patients, careful monitoring of blood glucose is recommended (see Section 4.8 Undesirable effects).

### **Aortic aneurysm and dissection**

Epidemiologic studies report an increased risk of aortic aneurysm and dissection after intake of fluoroquinolones, particularly in the older population.

Therefore, fluoroquinolones should only be used after careful benefit-risk assessment and after consideration of other therapeutic options in patients with positive family history of aneurysm disease, or in patients diagnosed with pre-existing aortic aneurysm and/or dissection, or in presence of other risk factors or conditions predisposing for aortic aneurysm and dissection (eg Marfan syndrome, vascular Ehlers-Danlos syndrome, Takayasu arteritis, giant cell arteritis, Behcet's disease, hypertension, known atherosclerosis).

In case of sudden abdominal, chest or back pain, patients should be advised to immediately consult a physician in an emergency department.

### **Information about excipients**

In patients for whom sodium intake is of medical concern (patients with congestive heart failure, renal failure, nephrotic syndrome, etc.), the additional sodium load of the solution for infusion should be taken into account. For sodium chloride content of the solution for infusion, see Section 2 QUALITATIVE AND QUANTITATIVE COMPOSITION.

## **4.5 Interaction with other medicines and other forms of interaction**

For the following substances, absence of a clinically relevant interaction with moxifloxacin was proven: atenolol, ranitidine, calcium supplements, theophylline, oral contraceptives, glibenclamide, itraconazole, digoxin, morphine, probenecid.

No dose adjustment is necessary for these medicines.

### **Antacids, Minerals and Multi-vitamins**

Concomitant ingestion of moxifloxacin together with antacids, minerals and multi-vitamins may result in impaired absorption of moxifloxacin after oral administration due to formation of chelate complexes with the multi-valent cations contained in these preparations. This may lead to plasma concentrations considerably lower than desired. Hence, antacids, anti-retroviral medicines (e.g. didanosine), and other preparations containing magnesium or aluminium, sucralfate and agents containing iron or zinc should be administered at least 4 hours before or 2 hours after ingestion of an oral moxifloxacin dose.

### **Ranitidine**

The concomitant administration with ranitidine did not change the absorption characteristics of moxifloxacin. Absorption parameters ( $C_{max}$ ,  $t_{max}$ , AUC) were comparable indicating absence of an influence of gastric pH on moxifloxacin uptake from the GI-tract.

### **Calcium Supplements**

When given with high dose calcium supplements, only a slightly reduced rate of absorption was observed while extent of absorption remained unaffected. The effect of high dose calcium supplements on the absorption of moxifloxacin is considered as clinically not relevant.

### **Theophylline**

In accordance with *in vitro* data, no influence of moxifloxacin on theophylline pharmacokinetics and *vice versa* at steady state was detected in humans, indicating that moxifloxacin does not interfere with the 1A2 subtypes of the cytochrome P450 enzymes.

### **Warfarin**

No interaction during concomitant treatment with warfarin on pharmacokinetics, prothrombin time and other coagulation parameters has been observed.

*Changes in INR (International Normalised Ratio):* Cases of increased anticoagulant activity have been reported in patients receiving anticoagulants concurrently with antibiotics, including moxifloxacin. The infectious disease (and its accompanying inflammatory process), age and general status of the patient are risk factors. Although an interaction between moxifloxacin and warfarin was not demonstrated in clinical trials, INR monitoring should be performed and, if necessary, the oral anticoagulant dosage should be adjusted as appropriate.

### **Oral Contraceptives**

No interaction has occurred following concomitant oral administration of moxifloxacin with oral contraceptives.

## **Antidiabetics**

No clinically relevant interaction was seen between glibenclamide and moxifloxacin .

## **Itraconazole**

Exposure (AUC) to itraconazole was only marginally altered under concomitant moxifloxacin treatment. Pharmacokinetics of moxifloxacin were not significantly altered by itraconazole. No dose adjustment is necessary for itraconazole when given with moxifloxacin and vice versa.

## **Digoxin**

The pharmacokinetics of digoxin are not significantly influenced by moxifloxacin and *vice versa*. After repeated dosing in healthy volunteers moxifloxacin increased  $C_{max}$  of digoxin by approximately 30% at steady state without affecting AUC or trough levels.

## **Morphine**

Parenteral administration of morphine with moxifloxacin did not reduce the oral bioavailability of moxifloxacin and only slightly decreased  $C_{max}$  (17%).

## **Atenolol**

The pharmacokinetics of atenolol are not significantly altered by moxifloxacin. Following single dose administration in healthy subjects AUC was marginally increased (by approximately 4%) and peak concentrations were decreased by 10%.

## **Probenecid**

No significant effect on apparent total body clearance and renal clearance of moxifloxacin was found in a clinical study investigating the impact of probenecid on renal excretion.

## **Charcoal**

Concomitant dosing of charcoal and 400 mg oral moxifloxacin reduced the systemic availability of the medicine by more than 80% by preventing absorption *in vivo*. The application of activated charcoal in the early absorption phase prevents further increase of systemic exposure in cases of overdose.

After intravenous medicine administration carbo medicinalis only slightly reduces systemic exposure (approximately 20%).

## **Food and Dairy Products**

Absorption of moxifloxacin was not altered by food intake (including dairy products). Moxifloxacin can be taken independently from food intake.

## **4.6 Fertility, pregnancy and lactation**



## Pregnancy

The safe use of moxifloxacin in human pregnancy has not been established. Reversible joint injuries are described in children receiving some fluoroquinolones, however this effect has not been reported as occurring on exposed fetuses. Animal studies have shown reproductive toxicity. The potential risk for humans is unknown.

Consequently, the use of moxifloxacin during pregnancy is contraindicated.

## Breastfeeding

As with other fluoroquinolones, moxifloxacin has been shown to cause lesions in the cartilage of the weight bearing joints of immature animals. Preclinical evidence indicates that small amounts of moxifloxacin may be secreted in human milk. There are no data available in lactating or nursing women. Therefore, the use of moxifloxacin in nursing mothers is contraindicated.

## Fertility

No data available.

### 4.7 Effects on ability to drive and use machines

Fluoroquinolones, including moxifloxacin, may result in an impairment of the patient's ability to drive or operate machinery due to CNS reactions and vision disorders (see Section 4.8 Undesirable effects).

### 4.8 Undesirable effects

Adverse drug reactions (ADRs) based on all clinical studies with moxifloxacin 400 mg (oral and sequential [IV/oral]/IV only administration) sorted by CIOMS III categories of frequency (overall n = 17,951, including n = 4,583 from sequential/intravenous therapy studies; status: May 2010) are listed below. ADRs listed under "common" were observed with a frequency below 3% with the exception of nausea and diarrhoea.

ADRs derived from post-marketing reports (status: May 2010) are printed in ***bold italic***.

Within each frequency grouping, undesirable effects are presented in order of decreasing seriousness. Frequencies are defined as:

Common	≥ 1/100 to < 1/10
Uncommon	≥ 1/1000 to < 1/100
Rare	≥ 1/10000 to < 1/1000
Very rare	< 1/10000

System Organ Class (MedDRA)	Common	Uncommon	Rare	Very Rare
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<b>Infections and Infestations</b>	Mycotic superinfections			
<b>Blood and the Lymphatic System Disorders</b>		Anaemia Leukopaenia(s) Neutropaenia Thrombocytopaenia Thrombocythaemia Prothrombin time prolonged / INR increased	Thromboplastin level abnormal	Prothrombin level increased / INR decreased Prothrombin level / INR abnormal
<b>Immune System Disorders</b>		Allergic reaction Pruritus Rash Urticaria Blood eosinophilia	Anaphylactic / anaphylactoid reaction  Allergic oedema / angioedema (incl. laryngeal oedema, potentially life threatening)	Anaphylactic / anaphylactoid shock (potentially life threatening)
<b>Metabolism and Nutrition Disorders</b>		Hyperlipidemia	Hyperglycaemia Hyperuricaemia	Hypoglycaemia
<b>Psychiatric Disorders</b>		Anxiety reactions Psychomotor hyperactivity/ agitation	Emotional lability Depression ( <i>in very rare cases potentially culminating in self-injurious behaviour, such as suicidal ideation/thoughts or suicide attempts</i> ) Hallucinations	Depersonalisation Psychotic reactions ( <i>potentially culminating in self-injurious behaviour, such as suicidal ideation/thoughts or suicide attempts</i> )
<b>Nervous System Disorders</b>	Headache Dizziness	Par- and Dysesthesia Taste disorders (incl. ageusia in very rare cases) Confusion and disorientation Sleep disorders Tremor Vertigo Somnolence	Hypoaesthesia Smell disorders (incl. anosmia) Abnormal dreams Disturbed coordination (incl. gait disturbances, esp. due to dizziness or vertigo; <i>in very rare cases leading to fall with injuries, esp. in elderly</i> ) Seizures of various clinical manifestations (incl. grand mal convulsions) Disturbed attention Speech disorders Amnesia Peripheral neuropathy and polyneuropathy	Hyperaesthesia

System Organ Class (MedDRA)	Common	Uncommon	Rare	Very Rare
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<b>Eye Disorders</b>		Visual disturbances (esp. in the course of CNS reactions)		Transient loss of vision (esp. in the course of CNS reactions)
<b>Ear and Labyrinth Disorders</b>			Tinnitus Hearing impairment including deafness (usually reversible)	
<b>Cardiovascular System Disorders</b>	QT prolongation in patients with hypokalaemia	QT prolongation Palpitations Tachycardia Vasodilatation	Ventricular tachyarrhythmias Syncope Hypertension Hypotension	Unspecified arrhythmias <b>Torsade de Pointes *</b> <b>Cardiac arrest *</b> <b>* (esp. in patients with severe underlying proarrhythmic conditions such as clinically significant bradycardia, acute myocardial ischaemia)</b>
<b>Respiratory, Thoracic and Mediastinal Disorders</b>		Dyspnoea (incl. asthmatic conditions)		
<b>Gastrointestinal Disorders</b>	Nausea Vomiting Gastrointestinal and abdominal pains Diarrhoea	Decreased appetite and food intake Constipation Dyspepsia Flatulence Gastroenteritis (excl. erosive gastroenteritis) Increased amylase	Dysphagia Stomatitis Antibiotic associated colitis (in very rare cases associated with life threatening complications)	
<b>Hepatobiliary Disorders</b>	Increase in transaminases	Hepatic impairment (incl. LDH increase) Increased bilirubin Increased gamma-glutamyl-transferase Increase in blood alkaline phosphatase	Jaundice Hepatitis (predominantly cholestatic)	<b>Fulminant hepatitis potentially leading to life-threatening liver failure (incl. fatal cases)</b>
<b>Skin and Subcutaneous Tissue Disorders</b>				<b>Bullous skin reactions like Stevens-Johnson-Syndrome or Toxic Epidermal Necrolysis (potentially life threatening)</b>

System Organ Class (MedDRA)	Common	Uncommon	Rare	Very Rare
<b>Musculoskeletal, Connective Tissue and Bone Disorders</b>		Arthralgia Myalgia	Tendonitis Increased muscle tone and cramping Muscular weakness	<b><i>Tendon rupture</i></b> Arthritis <b><i>Gait disturbance (caused by muscular, tendon or joint symptoms)</i></b> <b><i>Exacerbation of symptoms of myasthenia gravis</i></b>
<b>Renal and Urinary Disorders</b>		<b><i>Dehydration (caused by diarrhoea or reduced fluid intake)</i></b>	Renal impairment Renal failure (due to dehydration esp. in elderly with pre-existing renal disorders)	
<b>General Disorders and Administration Site Conditions</b>	Injection and infusion site reactions	Feeling unwell Unspecific pain Sweating Infusion site (thrombo-) phlebitis	Oedema	

In isolated instances, some serious adverse drug reactions may be long-lasting (> 30 days) and disabling; such as tendinitis, tendon rupture, musculoskeletal disorders, and other reactions affecting the nervous system including psychiatric disorders and disturbance of senses.

The following undesirable effects have a higher frequency in the subgroup of IV/oral sequentially treated patients:

Common: Increased gamma-glutamyl-transferase

Uncommon: Ventricular tachyarrhythmias, hypotension, oedema, vasodilatation, antibiotic associated colitis (in very rare cases associated with life threatening complications), seizures of various clinical manifestations (including grand mal convulsions), hallucination, renal impairment and renal failure (due to dehydration, especially in elderly with pre-existing renal disorders).

Reporting of suspected adverse reactions after authorisation of the medicine is important. It allows continued monitoring of the benefit/risk balance of the medicine. Healthcare professionals are asked to report any suspected adverse reactions <https://pophealth.my.site.com/carmreportnz/s/>

## 4.9 Overdose

Only limited data on overdose are available. Single doses of up to 1200 mg and multiple doses of 600 mg moxifloxacin over 10 days were administered to healthy subjects without any significant undesirable effects. In the event of overdosage it is

recommended that appropriate supportive care including ECG measurements should be instituted as dictated by the patient's clinical status.

The use of charcoal early after oral administration may be useful to prevent excessive increase of systemic exposure to moxifloxacin in cases of overdose.

For advice on the management of overdose, please contact the National Poisons Centre on 0800 POISON (0800 764 766)

## 5 PHARMACOLOGICAL PROPERTIES

### 5.1 Pharmacodynamic properties

#### Pharmacotherapeutic group

Quinolone antibacterials, fluoroquinolones

ATC Code: J01MA14

#### Mechanism of Action

Moxifloxacin is an 8-methoxy-fluoroquinolone antibiotic with a broad spectrum of activity and bactericidal action. Moxifloxacin has *in vitro* activity against a wide range of Gram-positive and Gram-negative organisms, anaerobes, acid-fast bacteria and atypicals e.g. *Chlamydia* spp., *Mycoplasma* spp. and *Legionella* spp.

The bactericidal action results from the interference with topoisomerase II and IV. Topoisomerases are essential enzymes that control DNA topology and assist in DNA replication, repair and transcription.

Moxifloxacin exhibits concentration dependent bactericidal killing. Minimum bactericidal concentrations are generally similar to minimum inhibitory concentrations.

Moxifloxacin is effective against  $\beta$ -lactam and macrolide resistant bacteria. Studies in animal models of infection have demonstrated high *in vivo* activity.

### 5.2 Pharmacokinetic properties

#### Absorption

Following oral administration, moxifloxacin is absorbed rapidly and almost completely. The absolute bioavailability amounts to approximately 91%.

Pharmacokinetics are linear in the range of 50 – 1200 mg single dose and up to 600 mg once daily dosing over 10 days. Steady state is reached within 3 days. Following a 400 mg oral dose peak concentrations of 3.1 mg/L are reached within 0.5 – 4 h post application. Peak and trough plasma concentrations at steady state (400 mg once daily) were 3.2 and 0.6 mg/L, respectively.

Concomitant administration of moxifloxacin together with food slightly prolongs the time to reach peak concentrations by approximately 2 hours and slightly reduced peak concentrations by approximately 16%. Extent of absorption remained unchanged. As AUC/MIC is most predictive for antimicrobial efficacy of

fluoroquinolones, this effect is clinically not relevant. Therefore, moxifloxacin can be administered independently from meals.

## Distribution

Moxifloxacin is distributed very rapidly to extravascular spaces. Exposure to medicine in terms of AUC ( $AUC_{norm} = 6 \text{ kg.h/L}$ ) is high with a volume of distribution at steady state ( $V_{ss}$ ) of approximately 2 L/kg. In saliva, peak concentrations higher than those of plasma may be reached. In *in vitro* and *ex vivo* experiments over a range of 0.02 to 2 mg/L, a protein binding of approximately 45% independent from the concentration of the medicine was determined. Moxifloxacin is mainly bound to serum albumin. Due to this low value high free peak concentrations > 10 x MIC are observed.

Moxifloxacin reaches high concentrations in tissues like lung (epithelial fluid, alveolar macrophages, biotic tissue), the sinuses (maxillary and ethmoid sinus, nasal polypi) and inflamed lesions (cantharide blister fluid) where total concentrations exceeding those of the plasma concentrations are reached. High free medicine concentrations are measured in interstitial body water (saliva, intramuscular, subcutaneous). In addition, high medicine concentrations were detected in abdominal tissues and fluids and female genital tract.

*Peak concentrations of moxifloxacin found in human tissues following oral (upper panel) and intravenous (lower panel) administration of a 400 mg single dose (geometric mean)*

Tissue	Concentration (p.o.)	Site: Plasma ratio (p.o.)
Plasma	3.1mg/L	--
Saliva	3.6 mg/L	0.75 - 1.3
Blister fluid	1.6 mg/L <sup>1</sup>	1.71
Bronchial mucosa	5.4mg/kg	1.7 - 2.1
Alveolar Macrophages	56.7 mg/kg	18.6 - 70.0
Epithelial lining fluid	20.7 mg/L	5 - 7
Maxillary sinus	7.5 mg/kg	2.0
Ethmoid sinus	8.2 mg/kg	2.1
Nasal Polyps	9.1 mg/kg	2.6
Interstitial fluid	1.0 mg/L <sup>2</sup>	0.8 - 1.4 <sup>2,3</sup>
Tissue	Concentration (i.v.)	Site: Plasma ratio (i.v.)
Plasma	4.1 mg/L	--
Saliva	5.0 mg/L	0.82 - 1.37
Blister fluid	1.75mg/L <sup>1</sup>	1.71
Interstitial fluid	1.0 mg/L <sup>2</sup>	0.8 - 2.5 <sup>2,3</sup>
Abdominal tissue <sup>4</sup>	7.03 mg/L	1.56
Abdominal exudate <sup>5</sup>	3.32 mg/L	1.45
Abscess fluid <sup>6</sup>	1.94 mg/L	0.74
Female genital tract <sup>4</sup>	10.2 mg/L	1.72

<sup>1</sup> 10 h after administration

<sup>2</sup> unbound concentration

<sup>3</sup> from 3 h up to 36 h post dose

<sup>4</sup> at the end of infusion

<sup>5</sup> 2 hours after administration

<sup>6</sup> 3 h after administration

The peak concentrations and site vs. plasma concentration ratios for various target tissues yielded comparable results for both modes of medicine administration after a single dose of 400 mg moxifloxacin

## Metabolism

Moxifloxacin undergoes Phase II biotransformation and is excreted via renal and biliary/faecal pathways as unchanged medicine as well as in the form of a sulfo-compound (M1) and a glucuronide (M2). M1 and M2 are the only metabolites relevant in humans. Both are microbiologically inactive. Metabolic pharmacokinetic interactions with other medicines undergoing Phase I biotransformation involving Cytochrome P450 enzymes were not observed in *in vitro* or in clinical Phase I studies.

Independent from the route of administration, the metabolites M1 and M2 are found in the plasma at concentrations lower than the parent medicine. Pre-clinical investigations adequately covered both metabolites, thus excluding potential implications with respect to safety and tolerability.

## Elimination

Moxifloxacin is eliminated from plasma with a mean terminal half-life of approximately 12 hours. The mean apparent total body clearance following a 400 mg dose ranges from 179 to 246 mL/min. Renal clearance amounted to about 24 – 53 mL/min suggesting partial tubular reabsorption of the medicine from the kidneys. Concomitant administration of ranitidine and probenecid did not alter renal clearance of the medicine (see also table below).

Mass balance of the mother compound and Phase II metabolites of moxifloxacin yielded an almost complete recovery of approximately 96% – 98% independent from the route of administration with no indication of oxidative metabolism. A detailed overview of the mass balance according to elimination pathways (renal vs. non-renal, metabolic vs. non-metabolic) and mode of application is given in the table below.

*Recovery of a 400 mg single dose (arithmetic mean  $\pm$  standard deviation (SD))*

	Moxifloxacin	Sulfo-compound (M1)	Glucuronide (M2)	$\Sigma$
Urine p.o.	19.4 $\pm$ 1.2	2.5 $\pm$ 0.6	13.6 $\pm$ 2.8	35.4 $\pm$ 1.8
Faeces p.o.	25.4 $\pm$ 3.1	35.5 $\pm$ 3.2	-	60.9 $\pm$ 5.1
$\Sigma$ p.o. (n=6)	44.8 $\pm$ 3.3	37.9 $\pm$ 3.6	13.6 $\pm$ 2.8	96.3 $\pm$ 4.3
Urine i.v.	21.9 $\pm$ 3.6	2.5 $\pm$ 0.9	13.8 $\pm$ 2.0	38.1 $\pm$ 2.1
Faeces i.v.	25.9 $\pm$ 4.3	34.4 $\pm$ 5.6	-	60.2 $\pm$ 9.2
$\Sigma$ i.v. (n=5)	47.8 $\pm$ 7.2	36.8 $\pm$ 5.9	13.8 $\pm$ 2.0	98.4 $\pm$ 10.5

## Resistance

Resistance mechanisms which inactivate penicillins, cephalosporins, aminoglycosides, macrolides and tetracyclines do not interfere with the antibacterial activity of moxifloxacin. There is no cross-resistance between moxifloxacin and these agents. Plasmid-mediated resistance has not been observed to date.

It appears that the C8-methoxy moiety contributes to enhanced activity and lower selection of resistant mutants of gram-positive bacteria compared to the C8-H moiety. The presence of the bulky bicycloamine substituent at the C-7 position prevents active efflux, a mechanism of fluoroquinolone resistance.

*In vitro* studies have demonstrated that resistance to moxifloxacin develops slowly by multiple step mutations. A very low overall frequency of resistance was demonstrated ( $10^{-7}$  –  $10^{-10}$ ). Serial exposure of organisms to sub-MIC concentrations of moxifloxacin showed only a small increase in MIC values.

Cross-resistance among fluoroquinolones has been observed. However, some gram-positive and anaerobic organisms resistant to other fluoroquinolones are susceptible to moxifloxacin.

#### *Effect on the Intestinal Flora in Humans*

In two volunteer studies, the following changes in the intestinal flora were seen following oral dosing with moxifloxacin. *E. coli*, *Bacillus* spp., *Bacteroides vulgatus*, *Enterococci*, and *Klebsiella* spp. were reduced, as were the anaerobes *Bifidobacterium*, *Eubacterium*, and *Peptostreptococcus*. These changes returned to normal within two weeks. *Clostridium difficile* toxin was not found.

#### *In vitro Susceptibility Data*

Susceptible	Intermediate	Resistant
<b>Gram-positive bacteria</b>		
<i>Gardnerella vaginalis</i>		
<i>Streptococcus pneumoniae</i> * incl. multi-drug resistant <i>S. pneumoniae</i> strains [MDRSP] incl. strains known as PRSP (Penicillin-resistant <i>S. pneumoniae</i> ), and strains resistant to two or more of the following antibiotics: penicillin (MIC $\geq$ 2 $\mu$ g/mL, 2 <sup>nd</sup> generation cephalosporins (e.g. cefuroxime), macrolides, tetracyclines and trimethoprim/sulfamethoxazole.		
<i>Streptococcus pyogenes</i> (group A)*		
<i>Streptococcus milleri</i> group ( <i>S. anginosus</i> *, <i>S. constellatus</i> *, and <i>S. intermedius</i> *)		
<i>Streptococcus viridans</i> group ( <i>S. viridans</i> , <i>S. mutans</i> , <i>S. mitis</i> , <i>S. sanguinis</i> , <i>S. salivarius</i> , <i>S. thermophilus</i> , <i>S. constellatus</i> )		
<i>Streptococcus agalactiae</i>		
<i>Streptococcus dysgalactiae</i>		
<i>Staphylococcus aureus</i> (methicillin susceptible strains)*		<i>Staphylococcus aureus</i> (methicillin/ofloxacin resistant strains)*



Coagulase negative Staphylococci ( <i>S. cohnii</i> , <i>S. epidermidis</i> , <i>S. haemolyticus</i> , <i>S. hominis</i> , <i>S. saprophyticus</i> , <i>S. simulans</i> ) methicillin susceptible strains		Coagulase negative Staphylococci ( <i>S. cohnii</i> , <i>S. epidermidis</i> , <i>S. haemolyticus</i> , <i>S. hominis</i> , <i>S. saprophyticus</i> , <i>S. simulans</i> ) methicillin resistant strains
	<i>Enterococcus faecalis</i> * (Vancomycin, Gentamycin susceptible strains only)	
	<i>Enterococcus avium</i> *	
	<i>Enterococcus faecium</i> *	

\* Clinical efficacy has been demonstrated for susceptible isolates in approved clinical indications.

+ Moxifloxacin is not recommended for the treatment of methicillin resistant *S. aureus* (MRSA) infections. In case of a suspected or confirmed infection due to MRSA, treatment with an appropriate antibacterial agent should be started.

Susceptible	Intermediate	Resistant
<b>Gram-negative bacteria</b>		
<i>Haemophilus influenzae</i> (incl. $\beta$ lactamase negative and positive strains)*		
<i>Haemophilus parainfluenzae</i> *		
<i>Moraxella catarrhalis</i> (incl. $\beta$ lactamase negative and positive strains)*		
<i>Bordetella pertussis</i>		
<i>Legionella pneumophila</i>	<i>Escherichia coli</i> *	
<i>Acinetobacter baumannii</i>	<i>Klebsiella pneumoniae</i> *	
	<i>Klebsiella oxytoca</i>	
	<i>Citrobacter freundii</i> *	
	Enterobacter species ( <i>E. aerogenes</i> , <i>E. intermedius</i> , <i>E. sakazaki</i> )	
	<i>Enterobacter cloacae</i> *	
	<i>Pantoea agglomerans</i>	
		<i>Pseudomonas aeruginosa</i>
	<i>Pseudomonas fluorescens</i>	
	<i>Burkholderia cepacia</i>	
	<i>Stenotrophomonas maltophilia</i>	
	<i>Proteus mirabilis</i> *	
<i>Proteus vulgaris</i>		
	<i>Morganella morganii</i>	
	<i>Providencia</i> species ( <i>P. rettgeri</i> , <i>P. stuartii</i> )	
	<i>Neisseria gonorrhoea</i> **	

\*/\*\* Clinical efficacy has been demonstrated for susceptible isolates in approved clinical indications

Susceptible	Intermediate	Resistant
<b>Anaerobes</b>		
	<i>Bacteroides</i> spp. ( <i>B. fragilis</i> *, <i>B. distasoni</i> *, <i>B. thetaiotaomicron</i> *, <i>B. ovatus</i> *, <i>B. uniformis</i> *, <i>B. vulgaris</i> *)	
<i>Fusobacterium</i> spp.		
	<i>Peptostreptococcus</i> spp.*	
<i>Porphyromonas</i> spp.		
<i>Prevotella</i> spp.		
<i>Propionibacterium</i> spp.		
	<i>Clostridium</i> sp*	

\* Clinical efficacy has been demonstrated for susceptible isolates in approved clinical indications

Susceptible	Intermediate	Resistant
<b>Atypicals</b>		
<i>Chlamydia pneumoniae</i> *		
<i>Chlamydia trachomatis</i> **		
<i>Mycoplasma pneumoniae</i> *		
<i>Mycoplasma hominis</i>		
<i>Mycoplasma genitalum</i>		
<i>Coxiella burnetti</i>		

\*/\*\* Clinical efficacy has been demonstrated for susceptible isolates in approved clinical indications

The frequency of acquired resistance may vary geographically and with time for certain species. Local area information on resistance of organisms is desirable, particularly when treating severe infections. The above information is provided as a guide on the probability of an organism being susceptible to moxifloxacin.

*Comparison of PK/PD surrogates for intravenous and oral administration of a 400 mg moxifloxacin single dose.*

In patients requiring hospitalisation, AUC/MIC<sub>90</sub> parameters greater than 125 and C<sub>max</sub> / MIC<sub>90</sub> of 8 – 10 is predictive for clinical cure (Schentag). In outpatients, these surrogate parameters are generally smaller, i.e. AUC/MIC<sub>90</sub> greater than 30 – 40 (Dudley and Ambrose).

The following table provides the respective PK/PD surrogates for intravenous and oral administration of 400 mg moxifloxacin calculated from single dose data:

Mode of administration	Intravenous		oral	
Parameter (median)	AUC [h]	C <sub>max</sub> /MIC <sub>90</sub> <sup>a)</sup>	AUC [h]	C <sub>max</sub> /MIC <sub>90</sub>
MIC <sub>90</sub> 0.125 mg/L	313	32.5	279	23.6
MIC <sub>90</sub> 0.25 mg/L	156	16.2	140	11.8
MIC <sub>90</sub> 0.5 mg/L	78	8.1	70	5.9

<sup>a)</sup> 1h infusion

### **Geriatric Patients**

Pharmacokinetics of moxifloxacin are not affected by age.

### **Gender**

There was a 33% difference in the pharmacokinetics (AUC,  $C_{max}$ ) of moxifloxacin between male and female subjects. Absorption was unaffected by gender. These differences in the AUC and  $C_{max}$  were attributable to the differences in body weight rather than gender. They are not considered as clinically relevant.

### **Ethnic Differences**

Possible interethnic differences were examined in Caucasian, Japanese, Black and other ethnic groups. No clinically relevant interethnic differences in pharmacokinetics could be detected.

### **Paediatric population**

Pharmacokinetics of moxifloxacin were not studied in paediatric patients.

### **Patients with Renal Impairment**

The pharmacokinetics of moxifloxacin are not significantly changed by renal impairment (including creatinine clearance  $< 30 \text{ mL/min/1.73m}^2$ ) and in patients on chronic dialysis i.e. haemodialysis and continuous ambulatory peritoneal dialysis.

### **Patients with Hepatic impairment**

Plasma concentrations of patients with mild to severe hepatic impairment (Child Pugh A to C) did not reveal clinically relevant differences compared to healthy volunteers or patients with normal hepatic function, respectively (see also Section 4.4 Special Warnings and Precautions for Use, in patients with liver cirrhosis).

## **5.3 Preclinical safety data**

As for other fluoroquinolones, the major toxicological target organs for moxifloxacin were the haemopoietic system (hypocellularity of the bone marrow in dogs and monkeys), the central nervous system (convulsions in monkeys) and the liver (raised liver enzymes, single cell necrosis in rats, dogs and monkeys). These changes were commonly seen only after treatment with high doses of moxifloxacin or after prolonged treatment.

In a local tolerability study performed in dogs, no signs of local intolerance were seen when moxifloxacin was administered intravenously. After intra-arterial injection, inflammatory changes involving the peri-arterial soft tissue were observed suggesting that intra-arterial administration of moxifloxacin should be avoided.

### **Carcinogenicity, Mutagenicity**

Although conventional long-term studies to determine the carcinogenic potential of moxifloxacin have not been performed, the medicine has been subject to a range of *in vitro* and *in vivo* genotoxicity tests. In addition, an accelerated bioassay for human carcinogenesis (initiation /promotion assay) was performed in rats. Negative results were obtained in 4 strains of the Ames test, in the HPRT mutation assay in Chinese hamster ovary cells and in the UDS assay in rat primary hepatocytes. As with other fluoroquinolones, the Ames test with TA 102 was positive and the *in vitro* test in the

Chinese hamster v79 cells showed chromosomal abnormalities at high concentrations (300 µg/mL). However, the *in vivo* micronucleus assay in the mouse was negative. An additional *in vivo* assay, the dominant lethal assay in the mouse, was negative as well. It is concluded that the negative *in vivo* results adequately reflect the *in vivo* situation in terms of genotoxicity. No evidence of carcinogenicity was found in an initiation/promotion assay in rats.

### **Phototoxicity**

Moxifloxacin is very photostable and has a very low potential for photogenotoxicity. *In vitro* and in animal models moxifloxacin seems to show less potency to induce phototoxicity and photogenotoxicity than other fluoroquinolones. Some fluoroquinolones have been shown to enhance the action of UV-A-induced photocarcinogenicity when administered concurrently to mice exposed to ultraviolet light. No photocarcinogenicity study has been performed with moxifloxacin. The lack of phototoxic potential has been confirmed in a Phase I study in volunteers.

### **ECG**

At high concentrations, moxifloxacin is an inhibitor of the delayed rectifier potassium current of the heart and may thus cause prolongations of the QT-interval. Toxicological studies performed in dogs using oral doses of  $\geq 90$  mg/kg leading to plasma concentrations  $\geq 16$  mg/L caused QT-prolongations, but no arrhythmias. Only after very high cumulative intravenous administration of more than 50 fold the human dose ( $> 300$  mg/kg), leading to plasma concentrations of  $\geq 200$  mg/L (more than 30 fold the therapeutic level after intravenous administration), reversible, non-fatal ventricular arrhythmias were seen.

### **Oculotoxicity**

Toxicity tests in rats and monkeys (repeated dosing up to six months) revealed no indication regarding an oculotoxic risk. In dogs, high oral doses ( $\geq 60$  mg/kg) leading to plasma concentrations  $\geq 20$  mg/L caused changes in the electroretinogram and in isolated cases an atrophy of the retina.

### **Arthrotoxicity**

Fluoroquinolones are known to cause lesions in the cartilage of the major diarthrodial joints in immature animals. The lowest oral dose of moxifloxacin causing joint toxicity in juvenile dogs was four times maximum recommended therapeutic dose (400 mg/50 kg person) on a mg/kg basis, with plasma concentrations two to three times higher than those at the recommended therapeutic dose.

### **Reprotoxicity**

Reproductive studies performed in rats, rabbits and monkeys indicate that placental transfer of moxifloxacin occurs. Studies in rats (per os and i.v.) and monkeys (per os) did not show evidence of teratogenicity or impairment of fertility following administration of moxifloxacin. Skeletal malformations were observed in rabbits that had been treated with an intravenous dose of 20 mg/kg. This study result is consistent with the known effects of fluoroquinolones on skeletal development (see Section 4.5 Interaction with other medicines and other forms of interaction and Section 4.6 Fertility, pregnancy and lactation). There was an increase in the incidence of abortions in monkeys and rabbits at human therapeutic concentrations.

In rats, decreased foetal weights, an increased prenatal loss, a slightly increased duration of pregnancy and an increased spontaneous activity of some male and female offspring were observed at doses which were 63 times the maximum recommended dose on a mg/kg basis, with plasma concentrations in the range of the human therapeutic dose.

## **6 PHARMACEUTICAL PARTICULARS**

### **6.1 List of excipients**

#### **Moxifloxacin Medsurge Film-coated Tablets**

- croscarmellose sodium
- lactose monohydrate
- magnesium stearate
- microcrystalline cellulose

The tablets are film-coated with a mixture of:

- iron oxide red
- iron oxide yellow
- hypromellose
- macrogol 4000
- titanium dioxide.

### **6.2 Incompatibilities**

None

### **6.3 Shelf life**

36 months

### **6.4 Special precautions for storage**

Store below 30°C.

### **6.5 Nature and contents of container <and special equipment for use, administration or implantation>**

#### **Nature and contents of container**

*Moxifloxacin Medsurge Film-coated Tablets* are packaged in PVC/PE/PVDC - Alu blister strips in packs of 5 tablets.

### **6.6 Special precautions for disposal <and other handling>**

Any unused medicine or waste material should be disposed of in accordance with local requirements.

## **7 MEDICINE SCHEDULE**

Prescription Medicine

## 8 SPONSOR

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PO Box 331054  
Takapuna  
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## 9 DATE OF FIRST APPROVAL

10 July 2025

## 10 DATE OF REVISION OF THE TEXT

Not Applicable

## SUMMARY TABLE OF CHANGES

Section changed	Summary of new information